Hydrologic Modeling Inventory
Model Response Form

Name of Model:

GR2M

(stands for : modèle du Génie Rural à 2 paramètres Mensuel (i.e. Rural Engineering Monthly 2-parameter model))

Model Type:

GR2M is a monthly lumped continuous rainfall-runoff model. It is of the soil moisture accounting storage type.

Model Objective(s):

The GR2M model was designed for streamflow simulation. It can be applied for a wide range of hydrological modeling applications (series extension, management, forecasting, design…).

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Model Structure or Mathematical Basis:

The GR2M model (see Mouelhi et al., 2006 for a full model description of the latest model version) is a monthly conceptual rainfall-runoff model developed for applications at the basin scale (lumped mode).

The model has been continuously developed since the beginning of the 1990s. The first model version was proposed by Kabouya (1990) and Kabouya and Michel (1991) and was later improved by Makhlouf (1994), Makhlouf and Michel (1994), Mouelhi (2003) and Mouelhi et al. (2006).

The production module of the model involves:

- a soil moisture accounting store to determine actual evapotranspiration and effective rainfall;
- a water exchange term that represents natural imports or exports of water (e.g. with deep aquifers)

The water transfer module involves only a non linear routing store.

Model Parameters:

The model has only two free parameters:

- the capacity of the production store, X1;
- the water exchange coefficient, X2;

The parameters have no direct physical interpretation and must be calibrated using observed flows.

Spatial Scale Employed in the Model:

The model is to be run in a lumped mode.

Temporal Scale Employed in the Model:

The model is to be run at a monthly time step.

Input Data Requirements:

The model requires as only input:

- monthly time-series of observed catchment areal rainfall;
- monthly time-series of potential evapotranspiration estimates (a mean interannual regime curve may be sufficient; see Oudin, 2004; Oudin et al. 2005).

Monthly observed streamflow time-series will be necessary to calibrate model parameters.

Computer Requirements:

Given its very simple structure, GR2M can even be run in a spreadsheet, there is no specific requirement.

Model Output:

The model simulates monthly streamflow time-series.

Parameter Estimation / Model Calibration:

Simple local search optimization algorithms are sufficient to locate a satisfactory model parameter optimum. A "step-by-step" method developed at Cemagref provides satisfactory results. Given only two parameters must be optimized, a manual calibration is easy.

Model Testing and Verification:

Model code was extensively tested and verified all along the successive steps of model development.

Model Sensitivity:

Model sensitivity to input data was studied by Paturel et al. (1995).

Model Reliability:

The model is considered as particularly robust thanks to its parsimony.

Model Application / Case Studies:

All along its development, the model was extensively tested on several hundreds of catchments (e.g. more than 400 basins in the study by Mouelhi, 2003):

- in France (Makhlouf, 1994; Mouelhi, 2003);
- in Algeria (Kabouya, 1990);
- in the United States (Mouelhi, 2003);

- in the Australia (Mouelhi, 2003);
- in the Ivory Coast (Mouelhi, 2003);
- in Brazil (Mouelhi, 2003);

The model was also applied for a large number of research and operational applications, e.g. in Western Africa (Servat et al., 1992, 1995; Paturel et al., 1995; Niel et al., 2003; Mahé et al., 2004).

Documentation:

Kabouya, M. (1990), Modélisation pluie-débit aux pas de temps mensuel et annuel en Algérie septentrionale, PhD thesis, 347 pp, Université Paris Sud Orsay.

Kabouya, M., and C. Michel (1991), Estimation des ressources en eau superficielle aux pas de temps mensuel et annuel, application à un pays semi-aride, Revue des Sciences de l'Eau, 4, 569-587.

Mahe, G., J. E. Paturel, E. Servat, D. Conway, and A. Dezetter (2004), The impact of land use change on soil water holding capacity and river flow modelling in the Nakambe River, Burkina-Faso, J. Hydrol., 300, 33-43.

Makhlouf, Z. (1994), Compléments sur le modèle pluie-débit GR4J et essai d'estimation de ses paramètres, PhD thesis, 426 pp, Université Paris XI Orsay.

Makhlouf, Z., and C. Michel (1994), A two-parameter monthly water balance model for French watersheds, J. Hydrol., 162, 299-318.

Mouelhi, S. (2003), Vers une chaîne cohérente de modèles pluie-débit conceptuels globaux aux pas de temps pluriannuel, annuel, mensuel et journalier, PhD thesis, 323 pp, ENGREF, Cemagref Antony, France.

Mouelhi, S., C. Michel, C. Perrin, and V. Andréassian (2006), Stepwise development of a two-parameter monthly water balance model, J. Hydrol., 318, doi:10.1016/j.jhydrol.2005.1006.1014.

Niel, H., J. E. Paturel, and E. Servat (2003), Study of parameter stability of a lumped hydrologic model in a context of climatic variability, J. Hydrol., 278, 213-230.

Paturel, J. E., E. Servat, and A. Vassiliadis (1995), Sensitivity of conceptual rainfall-runoff algorithms to errors in input data - case of the GR2M model, J. Hydrol., 168, 11-125.

Servat, E., and A. Dezetter (1991), Selection of calibration objective functions in the context of rainfall-runoff modelling in a sudanese savannah area, Hydrol. Sci. J., 36, 307-331.

Servat, E., and A. Dezetter (1992), Modélisation de la relation pluie-débit et estimation des apports en eau dans le nord-ouest de la Côte d'Ivoire, Hydrologie Continentale, 7, 129-142.